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United States
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Forest Service
Southern Region

Protection Report
R8-PR 20

Results of the 1990 Dogwood Anthracnose Impact Assessment and Pilot Test in the Southeastern United States

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United States Department of Agriculture
Forest Service - Southern Region
Forest Pest Management
Asheville, North Carolina

August 1991

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Contents

	Page
Contributors	2
Pesticide Precautionary Statement	4
Background	5
Literature Cited	9
Summary	10
Agencies That Participated in the Impact Assessment and Pilot Testing	12
Report Summaries	13
Individual Studies	
Distribution of Dogwood Anthracnose in the Southeastern United States - December 1990	17
Dogwood Anthracnose Impact Assessment in the Southeast - 1990	25
A Preliminary Hazard Rating for Dogwood Anthracnose in the Southern Appalachians	34
Effectiveness of Cultural Techniques to Control Dogwood Anthracnose	39
Residual Effects of Control Strategies Applied in the Previous Year	44
Use of Fungicial Sprays and Pruning to Control Dogwood Anthracnose in a Nursery Field	47
Dogwood Anthracnose Studies	49
Chemical and Cultural Control of Dogwood Anthracnose at Lookout Mountain National Park	57
A Pilot Test of the Fungicide Lynx Used as a Soil Drench to Control Dogwood Anthracnose	60
A Pilot Test of the Fungicide Banner Used as a Soil Drench to Control Dogwood Anthracnose	64
Evaluation of Growth Retardant for Epicormic Shoot Control on Flowering Dogwoods	68
Epicormic Shoot Dieback of Flowering Dogwood Caused by *Discula* sp. During Dormancy	69
Correlation Between Simulated Acid Rain and Dogwood Anthracnose in the Greenhouse	70

Results of the 1990 Dogwood Anthracnose Impact Assessment and Pilot Test in the Southeastern United States

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Pesticide Precautionary Statement

This publication reports pilot testing involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

BACKGROUND

Dogwood anthracnose is a disease of flowering and Pacific dogwood, (Cornus florida L. and C. nuttallii Audubon). Infection of Pacific dogwood has been reported from Washington, Oregon, Idaho, and British Columbia. In the South, infections have been reported on flowering dogwood in Virginia, North and South Carolina, Tennessee, Georgia, Kentucky, and Alabama.

Infection of dogwoods is favored by cool, wet spring, and fall weather but can occur throughout the growing season. Drought and winter injury weaken trees and may increase disease severity. Consecutive years of heavy infection have resulted in extensive mortality of both woodland and ornamental dogwoods. The origin of this disease is unknown, but it is suspected to have been introduced.

Dogwood anthracnose was first reported in 1978. It was causing a widespread, rapid deterioration of flowering dogwood in New York and Connecticut. In 1983, Daughtrey and Hibben (2) reported a lower branch dieback disease with the same symptoms on flowering dogwood in New York, Connecticut, New Jersey, and Pennsylvania. They made observations on trees in Planting Fields Arboretum, Oyster Bay, Long Island, and a woodland site at the Brooklyn Botanic Garden Research Center at Ossining, New York. They reported the cause of the disease to be a species of Discula. Daughtrey and Hibben (2) reported that the reason for a sudden onset of anthracnose over part of the northeastern range and its coincidental outbreak on western flowering dogwood was unknown. They speculated that climatic changes may have been a factor and that the disease may have been introduced. Hudler proposed that droughts or sudden changes in the environment may have predisposed the trees to infection (3). In 1984 a survey of dogwood anthracnose was made in Catoctin Mountain National Park. Mielke and Langdon in 1986 found that only 3 percent of the dogwoods were disease free, and that about one-third were dead (5). Schneeberger Jackson repeated the survey in 1988 and found that 89 percent of the dogwoods were dead, that there was almost no regeneration, and that all remaining trees were diseased (6).

Byther and Davidson described a similar disease on western flowering dogwoods in western Washington and named it dogwood anthracnose. The disease was reported in Oregon, Idaho, and British Columbia in 1983 (1). The casual organism was reported to be Discula. Daughtrey and Hibben compared the symptoms, signs, and organisms on the western flowering dogwood and the eastern flowering dogwood. They concluded that the same disease occurs in both areas. It was at this time that the disease on eastern flowering dogwood was named dogwood anthracnose (2). In 1985 Mielke and Daughtrey wrote a pest alert designed to help assess the distribution and spread (4). By 1987 the disease had been reported in over 60 counties in 9 Northeastern States (Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Virginia, and West Virginia). In the late 1970's and early 1980's there was considerable speculation as to whether dogwood anthracnose could successfully spread to the Southeastern United States. In October of 1987, unusual numbers of dogwoods were reported dying on the Cohutta Ranger District on the Chattachoochee National Forest in Northern Georgia. All of the symptoms matched those of dogwood anthracnose. Foresters estimated that the affected area covered about 30,000 acres of the Cohutta Wilderness. Discula, the casual organism of dogwood anthracnose, was isolated from samples from the affected area.

The National Forest Supervisor and State Forester of Georgia were notified of the occurrence. Soon thereafter, Bob Zahner, a professor from Clemson University, reported an unusual problem with the dogwoods in Cashiers, North Carolina. This area was checked and Discula was found. In this case, the affected area was much larger than the 30,000 acres found in Georgia. At this time, the State Forester of North Carolina was notified, and a meeting of State and Federal personnel from the affected and adjacent States was held in Dillard, Georgia, in February 1988. This group became a dogwood anthracnose working group and agreed that the top priority was to assess the disease distribution. The Southern Region of the Forest Service distributed a southern version of the dogwood anthracnose pest alert.

By the second meeting of the working group in May of 1988, the disease had been found in Georgia, North Carolina, South Carolina, Tennessee, and Virginia. It was reported that the disease affected trees of all sizes and was more common in the mountains and cool wet valleys. Six nurseries in North Carolina and one in South Carolina were reported to have diseased trees. Fungicide trials were started in Georgia and Tennessee, and a joint pilot test proposal was prepared for submission to the Washington Office. Coleman Doggett, North Carolina Pest Control Forester proposed that permanent plots be established on a 15-mile grid to assess the current and future impacts. These plots were installed by State and Federal personnel in each of the respective States. In June of 1988, the fungus had been found in so many locations that the USDA Forest Service and the University of Georgia began to provide sample identification services. In September the working group developed a news release, but it was decided not to send the release until more information was collected. After this point, the information became known to the press and public. As a result, the news release was never issued. The National Park Service did distribute a news release from the Great Smoky Mountains National Park. Dogwood anthracnose and its impact received major media coverage.

At this point, a lot of work was being done, and the working group concept was good, but the process was reactive and information was not being managed to assist in the process. The public was getting scarce information from the press, and politicians were responding to the problem without knowing the whole story. A third meeting of the dogwood anthracnose working group was held in October 1988. By this time, a funding proposal had been submitted to the Washington Office for consideration. The disease had been identified in 49 counties in the South, and 60 permanent plots had been established to assess impact. Birds were discussed as possible vectors, and fungicide studies in Georgia had not produced positive results. Fungicides had been applied in the late summer. One important concern was the inability to inoculate trees under controlled conditions. A high priority was placed on this task. In November of 1988, the Great Smoky Mountain National Park in cooperation with the University of Tennessee completed a survey of the Park and found the disease was widespread.

In January of 1989, the Regional Forester for the Southern Region of the USDA Forest Service called a meeting of the Federal and State cooperators to discuss dogwood anthracnose. At this meeting, a list of priorities was developed for survey, impact assessment, and research, and a dogwood anthracnose steering committee was developed to help with the biological and political aspects of the problem.

In March 1989, eight national forests were surveyed to assess the distribution. At the same time, a greenhouse inoculation test was completed with positive results. Anderson, Knighten, and Dowsett found when seedling leaves were pretreated with an acid mist, fungus spores routinely produced infections on them. Results led to a controlled acid rain study where a positive correlation was established between simulated acid rain and infection in the greenhouse. Funding was approved for a pilot test of control techniques, and several studies were started by the USDA Forest Service, the University of Tennessee, the University of Georgia, and the National Park Service.

In the spring of 1989, the media coverage picked up considerably. The story ran in dozens of newspapers and on radio and TV. CBS National News did a Saturday segment on the disease. Realizing the need to provide the best information possible to the public, the USDA Forest Service, the University of Georgia, and the State Forester of Georgia developed and published a booklet on how to manage dogwood anthracnose. To keep public officials informed, a briefing package was developed by the Forest Service. The package included a briefing paper and a list of people to be contacted. It was about this time that the correlation between simulated acid rain and dogwood anthracnose was released. Because of the interest in acid rain, major political problems arose as the information was released to the press. In 1990 the acid rain study was repeated and showed the same result. At this time, proposals for research and impact assessment were being submitted to the Washington Office. The Southeastern Forest Experiment Station assigned one person to work part time on the disease in 1989. By this time, the disease had been found in 57 counties in 7 Southern States.

By 1990 considerable information was accumulating. It was noted that the fungus seemed to remain active and grow down the shoots in the winter. The disease was more common at high elevations and in cool, wet coves was able to spread over large areas very quickly (81 counties now had diseased trees), and the fungus preferred cool temperatures. Pilot test data showed that the fungicides Benlate and Daconil were providing effective control and that other fungicides showed promise. Fertilization and mulching seemed to improve tree vigor, while not increasing the disease in the field. Other greenhouse and field tests were showing that phosphorus tended to increase and lime tended to reduce disease symptoms.

Nevertheless, we still knew very little about this complex problem. Early literature reported that there was no resistance in the native flowering dogwood populations, but people were noting some trees in the field that seemed to show resistance. Resistance became a high priority for research in 1990.

In September of 1989, the working group met again to discuss progress. Eighty-four counties were reported with diseased trees, and the impact plots showed the disease had increased from one-half million acres in 1988 to 2.2 million acres in 1989. The National Park Service announced that it would investigate mycological aspects of the problem. Forest Service research officials reported that they would be working on epidemiology.

In December 1989, Kerry Britton of the Southeastern Forest Experiment Station held a research planning meeting in Athens, Georgia. The Station had received funding for anthracnose research, and the purpose of the meeting was to develop a plan for the next 5 years.

Forest Pest Management recently evaluated a forest stand that had a major component of dogwood near Asheville, North Carolina. After about 3 years of infection, 42 percent of the dogwoods have died, the remainder are infected, and there is no regeneration. The disease is spreading rapidly, heavily impacting large areas.

In the fall of 1990, the Southern Appalachian Man and Biosphere Cooperative (SAMAB), consisting of the U.S. Environmental Protection Agency, Forest Service, Park Service, Southeastern Forest Experiment Station, Fish and Wildlife Service, Department of Energy, Economic Development Administration, and the Tennessee Valley Authority, organized two dogwood anthracnose conferences. One was held in Knoxville, Tennessee, and the other in Asheville, North Carolina. These conferences consisted of representatives from Federal, State, and private concerns, and featured speakers from a number of these agencies. The program reflected a diversity of views held by various groups throughout the South. These meetings increased the awareness of and understanding of dogwood anthracnose, and helped define specific goals, such as effective information dissemination.

Disease distribution has been difficult to determine. For any major pest problem, the first question is "Where is the disease found?" For this disease, incidence maps would be very useful. Since there are so many mimicking symptoms, it was decided that for a county to be called affected, presence of the disease had to be confirmed in the laboratory.

For impact assessment, some 210 permanent 10-tree dogwood plots have been established in North Carolina, South Carolina, Tennessee, Alabama, Virginia, Kentucky, and Georgia. These plots are on a 15-mile grid. Data gathered on the plots in 1988 and 1989 show that the disease increased dramatically (from about 1/2 million acres in 1988 to 2.1 million acres in 1989), and that severity on the permanent plots has increased. Obviously, the rapid increase in area and acreage reflects discovery of areas infected for some time, in addition to actual yearly increase. However, from observation of infection in fairly large geographic areas, it is clear that there was a major increase in the disease in 1989. In 1990 the plot data were entered onto a Geographic Information System in an attempt to produce maps showing severity as well as incidence.

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SUMMARY

By December of 1990, dogwood anthracnose had been found in 126 counties in 7 Southern States. The increase over 1989 in number of affected counties was 35 percent. About 5.7 million acres are estimated to be affected, and mortality is increasing. Preliminary work on hazard rating systems seems to show a correlation between disease severity and elevation. The higher the elevation, the more severe the damage to the dogwood resources. In addition, work by the Great Smoky Mountains National Park has shown a relationship between disease occurrence and aspect and proximity to water.

1. Select healthy trees to plant.
2. Purchase trees from a reputable nursery; do not transplant trees from the wild.
3. Select planting sites where foliage will dry rapidly in the morning and afternoons.
4. Use proper planting techniques.
5. Prune and destroy dead wood and leaves yearly; prune trunk sprouts in the fall.
6. Water weekly in the morning during droughts. Caution: Do not wet foliage.
7. Maintain 4- to-6 inch-deep mulch around trees; do not use dogwood chips as a mulch.
8. Fertilize according to soil analysis.
9. Use proper insecticide and fungicide where appropriate.
10. Avoid mechanical and chemical injury to trees.

The recommended cultural control techniques appear to be effective in reducing disease severity. General pruning seems to be of little value, but removal of epicormic shoots helps to prevent stem infection. Watering during drought is effective, but the watering must be done in the morning and not touch the foliage. Mulching helps by reducing moisture stress and reducing trunk wounding. All fertilizer treatments resulted in reduced infection when compared with the check. Nitrogen seemed to be most effective.

A number of fungicides were sprayed on foliage, injected into stems and used as soil drenches. No injections or drenches worked. Several fungicides worked as foliage sprays. Two registered fungicides, Benlate and Daconil, gave excellent control as foliage sprays. Other fungicides, such as Lynx, gave better control but are not registered for this purpose. A chemical, Maintain A, was tested to reduce epicormic shoot formation but it was translocated in the plant, producing undesirable effects.

A greenhouse test in 1989 showed a relationship between simulated acid rain and disease symptom development. This test was repeated in 1990 with the same results.

A 1991 dogwood anthracnose pilot test is planned. The test will: (1) track the distribution, (2) assess impact changes, (3) test fungicide spray schedules, (4) continue to assess the cultural control techniques, (5) refine the hazard rating, and (6) look at the possible fertilizer interaction.

AGENCIES THAT PARTICIPATED IN THE IMPACT ASSESSMENT AND PILOT TESTING

USDA Forest Service - Forest Pest Management

- Distribution of Dogwood Anthracnose
- Cultural and Chemical Control Techniques
- Simulated Acid Rain Correlation
- Pruning Evaluation

University of Georgia

- Chemical and Cultural Control Techniques
- Pruning Evaluations

Great Smoky Mountains National Park

- Hazard Rating
- Chemical and Cultural Control

State Foresters' Offices - Alabama, North Carolina, South Carolina, Virginia, Georgia and Tennessee.

- Distribution of Dogwood Anthracnose
- Impact of Dogwood Anthracnose

REPORT SUMMARIES

The individual report section contains the detailed reports for each of the assessments and pilot tests. A brief summary of each report follows:

DISTRIBUTION OF DOGWOOD ANTHRACNOSE IN THE SOUTHEASTERN UNITED STATES - DECEMBER 1990

ABSTRACT

Since dogwood anthracnose was found in the Southeastern United States, people from State, Federal, and private concerns have helped track its distribution. To be added to the distribution map, a county must have diseased trees and have Discula sp. confirmed in the laboratory. By December 1990, 126 counties were classified in 7 Southern States as having infected trees.

DOGWOOD ANTHRACNOSE IMPACT ASSESSMENT IN THE SOUTHEAST - 1990

Two hundred and ten permanent dogwood plots have been established in dogwood anthracnose affected counties in Virginia, North Carolina, South Carolina, Georgia, Kentucky, Tennessee, and Alabama. These plots were selected as a random stratified sample on a 15-mile grid. The acreage affected in the Southeast was estimated at about 1/2 million acres in 1988, 2.2 million in 1989, and increased to 5.7 million acres in 1990. Mortality increased from 0 to 3 percent from 1988 to 1990 and the percentage of severely damaged trees increased from 4 to 11 percent.

PRELIMINARY HAZARD RATING FOR DOGWOOD ANTHRACNOSE IN THE SOUTHERN APPALACHIANS

Most dogwood anthracnose workers have recognized a difference in infection rates in different habitats when conducting field surveys. This study indicates that there is a significant difference across the landscape (in the park) that may be attributable to temperature and moisture changes that are, in turn, influenced by topography and distance from streams.

EFFECTIVENESS OF CULTURAL TECHNIQUES TO CONTROL DOGWOOD ANTHRACNOSE

Ornamental dogwood trees at the Bent Creek Experimental Forest in Asheville, North Carolina, were treated with different cultural techniques. All treated trees were pruned, mulched, and sprayed for dogwood borers. In addition, some trees received nitrogen, phosphorus, lime, or a balanced fertilizer, or were watered during dry periods. Check trees received none of the treatments. The trees were classified as being in full sun, in partial shade, or in full shade, and as high vigor, moderate vigor, or low vigor. There was no correlation between the sun position and disease severity. All fertilizer and the water treatments were correlated with reduced disease

development. Nitrogen fertilization had the lowest disease rating. It was also noted that watering in the afternoon increased disease symptoms and that cankers formed on the main stem if the epicormic shoots were not pruned.

DOGWOOD ANTHRACNOSE STUDIES
UNIVERSITY OF GEORGIA

Of the registered materials, Benlate and Daconil gave the best control of dogwood anthracnose leaf symptoms. Benlate was statically better, although both materials gave adequate control. Lynx, not registered for use on dogwood, was as effective as a foliar spray as Benlate. Due to the potential resistance problem with Benlate, it is suggested that the materials be mixed or alternated in a common spray schedule. Trunk injections with Aliette, Lynx, Arbotect, or Plant Vax were relatively ineffective in reducing foliar symptoms regardless of time or number of injections.

PILOT TESTS AT THE
UNIVERSITY OF TENNESSEE

Fungicide treatments, including Banner, Bravo 720, Benlate, Dithane, Systhane, and Lynx were effective in reducing dogwood anthracnose incidence in the nursery tree canopies. Pruning treatments were also effective in reducing disease incidence, but not as effective as were fungicidal treatments. Pruning plus fungicides were no more effective than fungicides alone. The use of tree injectors or soil drenches to deliver fungicide treatments did not reduce disease incidence or severity.

In other tests, tree location (shade vs. full sun), mulching, and irrigation did not influence disease severity or incidence. This may have been due to unusual dry and hot weather. Trees used in fungicidal trials in 1989 continued to be rated at a lower disease severity levels than control trees.

A PILOT TEST OF THE FUNGICIDE LYNX USED AS A
SOIL DRENCH TO CONTROL DOGWOOD ANTHRACNOSE

Flowering dogwood that are severely affected by dogwood anthracnose on the Bent Creek Experimental Forest were used to pilot test the fungicide Lynx as a soil drench for the control of dogwood anthracnose. The trees were treated by pouring a dilute mixture of the chemical in holes that had been bored in the soil around the drip line. There were no differences in the severity of the disease from May 1990 to September 1990 in the treat trees.

A PILOT TEST OF THE FUNGICIDE BANNER USED AS A
SOIL DRENCH TO CONTROL DOGWOOD ANTHRACNOSE

Flowering dogwood that are severely affected by dogwood anthracnose on the Bent Creek Experimental Forest were used to pilot test the fungicide Banner as a soil drench for the control of dogwood anthracnose. The trees were treated by pouring a dilute mixture of the chemical in holes that had been bored in the soil around the drip line. There was no difference in the severity of the disease from May 1990 to September 1990 in the treated trees.

EPICORMIC SHOOT DIEBACK OF FLOWERING DOGWOOD CAUSED BY DISCULA SP. DURING DORMANCY

Increased dieback of epicormic shoots was observed on flowering dogwood after the tree had gone dormant in 1987 and 1988. Further verification of this observation was made during the dormant season (October to May) in 1989. During the evaluation, 66 percent of the shoots had varying amounts of dieback; 17 percent died back to the main stem, while 17 percent remained unchanged. The evaluation showed that the increase in dieback occurred after an extreme cold period. The progression of dieback was limited by shoot internodes.

EVALUATION OF GROWTH RETARDANT FOR EPICORMIC SHOOT CONTROL ON FLOWERING DOGWOODS

Maintain A tree sprout growth retardant was used to reduce epicormic shoot formation on flowering dogwoods. The treatment caused stem and branch deformity in small trees and is not recommended for use on dogwoods.

CORRELATION BETWEEN SIMULATED ACID RAIN AND DOGWOOD ANTHRACNOSE IN THE GREENHOUSE

Bare-root, 1 year-old Cornus florida seedlings were planted in 1-liter pots in a mixture of 5 parts peat moss, 4 parts perlite, and 3 parts pasteurized topsoil. When leaves had emerged under controlled greenhouse conditions, the seedlings were exposed to one of four simulated rains with pH of 2.5, 3.5, 4.5, and 5.5 at the Center for Forest Environmental Studies. After 10 exposures, the seedlings were sealed in plastic bags and transported to the Resistance Screening Center, where they were inoculated with Discula sp., the dogwood anthracnose fungus. After 21 days the percentage of seedling leaves infected and the severity of infection were assessed. The study was done in 1989 and repeated in 1990. In both years, Discula-caused symptom severity increased as the simulated acid rain pH decreased from 5.5 to 2.5.

INDIVIDUAL STUDIES

DISTRIBUTION OF DOGWOOD ANTHRACNOSE IN THE SOUTHEASTERN UNITED STATES - DECEMBER 1990 [1/]

by

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ABSTRACT

Since dogwood anthracnose was found in the Southeastern United States, people from State, Federal, and private concerns have helped track its distribution. To be added to the distribution map, the diseased trees must be present in the county and have Discula sp. confirmed in the laboratory. By December 1990, 126 counties were classified in 7 Southern States as having infected trees.

INTRODUCTION

In the late 1970's a new disease (dogwood anthracnose) was found to be causing lower limb dieback and leaf lesions on flowering dogwoods (Cornus florida) in the Northeastern United States (2). In 1987 the disease caused by the fungus Discula sp. (3) was found to be affecting 30,000 acres of Cohutta Wilderness in northern Georgia (1).

Since the disease's discovery in the Southeastern United States, Federal, State, and private concerns have helped track the distribution and spread of the disease. Forest Pest Management, Region 8 has coordinated the data and prepared distribution maps for the Southeast.

METHODS

In 1987 and 1988, the States of Georgia, North Carolina, South Carolina, Tennessee, the National Park Service, and the USDA Forest Service conducted dogwood anthracnose road surveys of the mountains and foothills in their respective areas. Symptomatic dogwoods were sampled and samples were sent to

[1/] A large number of people and agencies contributed data to prepare this map. Figure 2 lists the contributors.

the Horticultural Research Laboratory at Cornell University for confirmation of the disease. A list of counties, by State, that had at least one natural growing dogwood tree, confirmed in the laboratory to be infected with the dogwood anthracnose fungus Discula sp., was started.

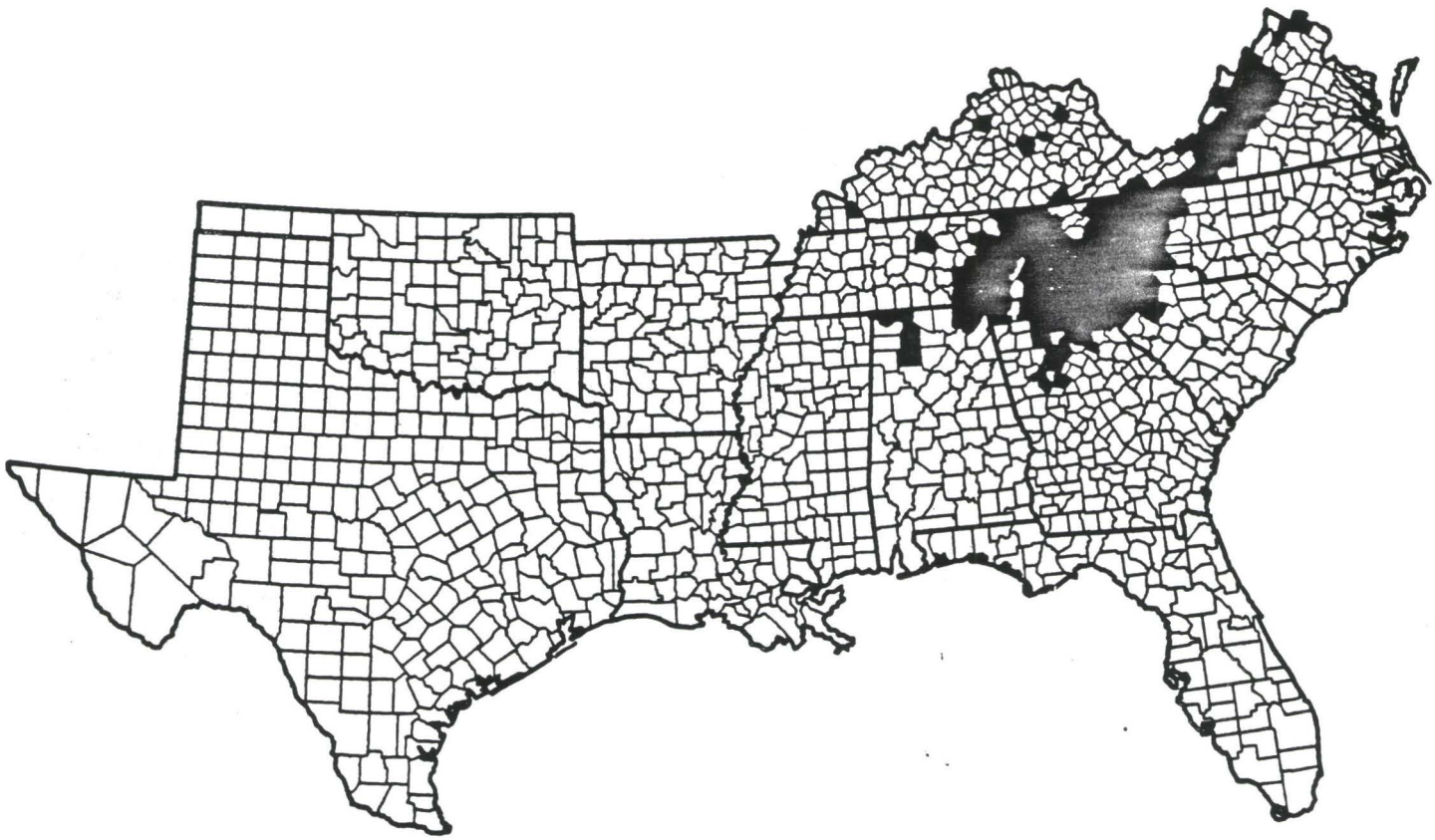
In 1989 and 1990, the survey data came from anyone who discovered an infected tree and had it confirmed in the laboratory. The person or agency reporting a specific county has been recorded from the start of the mapping activities in 1987. Counties where all of the diseased trees have been removed are not added to the map. The maps are kept up to date using a Geographic Information System, maintained by the Regional Office in Atlanta, Georgia.

RESULTS AND DISCUSSION

The list of counties in the Southeast has grown from 3 counties in 1987 to 126 in December 1990 (table 1 and fig. 1). In 1988 and 1989, the surveys and observations were detecting new areas and places where the disease had been around for some time. In 1990 the surveys and observations began to detect primarily the spread of the disease into new areas.

The disease is primarily found in the mountains, foothills, and upper Piedmont. Damage is more severe at the higher elevations and in cool moist areas in the lower elevation.

Figure 1.--Distribution of dogwood anthracnose in the Southeastern United States as of December 1990.[1/]



[1/] Map was prepared by Bob Uhler, Steve Holzman, and Charles Dull with the Geographic Information System in the Regional Office.

Table 1.--Number of counties, by year, confirmed in the laboratory to have at least one flowering dogwood tree infected with dogwood anthracnose

State	Year counties were added to the map				
	87	88	89	90	Total
Alabama	--	--	3	1	4
Georgia	1	6	11	9	27
Kentucky	--	--	1	4	5
North Carolina	--	13	5	6	24
South Carolina	--	5	1	--	6
Tennessee	--	15	14	8	37
Virginia	2	3	13	5	23
Total	3	42	48	33	126

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Figure 2.--List of the person or agency that first found dogwood anthracnose in a county.

STATE	COUNTY	SOURCE OF INFORMATION
NC	Allegheny	S. Spencer
		R. Baldwin
	Ashe	D. Rogers
	Avery	J. Knighten
	Buncombe	B. Anderson
		J. Knighten
	Burke	S. Dowsett
	Caldwell	D. Rogers
	Cherokee	S. Dowsett
	Clay	S. Dowsett
	Cleveland	S. Oak
	Graham	B. Anderson
		S. Dowsett
	Haywood	M. Windham
		(Smokies)
	Henderson	D. Ledford
	Jackson	B. Anderson
		J. Knighten
		D. Ledford
	Macon	B. Anderson
		J. Knighten
	Madison	S. Dowsett
	McDowell	J. Knighten
	Mitchell	J. Knighten
		S. Dowsett
	Polk	S. Spencer
	Rutherford	J. Knighten
	Swain	M. Windham
		(Smokies)
	Transylvania	B. Anderson
		J. Knighten
		D. Ledford
	Watauga	NCSU Plant Path
		Clinic
	Wilkes	D. Rogers
	Yancey	Plot Data
VA	Albermarle	J. Stipes
	Amherst	T. McCartney
	Augusta	J. Knighten
	Bath	T. McCartney
	Bedford	Blue Ridge Parkway
	Botetourt	Blue Ridge Parkway
	Carroll	Blue Ridge Parkway
	Clarke	Data From Plant Disease
	Craig	T. McCartney
	Floyd	D. Anderson
	Franklin	Blue Ridge Parkway

	Giles	T. McCartney
	Grayson	Blue Ridge Parkway
	Greene	K. Langdon
	Loudoun	Data From Plant Disease
	Montgomery	J. Stipes
	Nelson	J. Artman
	Patrick	Blue Ridge Parkway
	Roanoke	Blue Ridge Parkway
	Rockbridge	Drake
	Rockingham	D. Rogers
	Warren	S. Dowsett
	Washington	T. McCartney
SC	Anderson	A. Boone
	Greenville	A. Boone
	Laurens	Plot Data
	Oconee	A. Boone
	Pickens	A. Boone
	Spartanburg	Plot Data
AL	Jackson	B. Anderson
		J. Knighten
	Lauderdale	N. Hess
	Lawrence	N. Hess
	Winston	N. Hess
TN	Anderson	M. Windham
	Bledsoe	B. Kauffman
	Blount	M. Windham
		(Smokies)
	Campbell	B. Kauffman
	Carter	B. Kauffman
	Cocke	M. Windham
	Coffee	B. Kauffman
	Cumberland	B. Kauffman
	Davidson	B. Kauffman
	Fentress	B. Kauffman
	Franklin	B. Kauffman
	Greene	B. Kauffman
	Grundy	B. Kauffman
	Hamilton	B. Kauffman
	Hawkins	B. Kauffman
	Johnson	B. Kauffman
	Loudon	B. Kauffman
	Knox	M. Windham
	Marion	B. Kauffman
	McMinn	B. Kauffman
	Monroe	B. Kauffman
	Morgan	B. Kauffman
	Pickett	B. Kauffman
	Polk	M. Windham
		B. Kauffman
	Putnam	B. Kauffman
	Rhea	M. Windham
	Roane	B. Kauffman
	Sequatchie	B. Kauffman
	Sevier	M. Windham
		(Smokies)

	Scott	B. Kauffman
	Sullivan	S. Dowsett
	Unicoi	Plot Data
	Union	B. Kauffman
	Vanburen	B. Kauffman
	Warren	B. Kauffman
	Washington	B. Kauffman
	White	B. Kauffman
KY	Rowan	S. Dowsett
	Powell	J. Hartman
	Bell	J. Hartman
	Madison	J. Hartman
	Marshall	J. Hartman
GA	Banks	K. Bailey
	Catoosa	M. Windham
	Cherokee	K. Bailey
	Clarke	K. Bailey
	Dade	M. Windham
	Dawson	F. Hendrix
	De Kalb	K. Bailey
	Fannin	S. Dowsett
	Fayette	K. Bailey
	Franklin	F. Hendrix
	Fulton	K. Bailey
	Gilmer	S. Dowsett
	Gwinett	K. Bailey
	Habersham	Plot Data
	Hall	F. Hendrix
	Hart	F. Hendrix
	Henry	K. Bailey
	Jackson	Ed Brown
	Lumpkin	J. Knighten
	Murray	S. Dowsett
	Pickens	K. Bailey
	Rabun	B. Anderson
		J. Knighten
		S. Dowsett
	Stephens	F. Hendrix
	Towns	J. Knighten
	Union	K. Britton
	Walker	M. Windham
	White	K. Britton

Report # 91-1-25

Dogwood Anthracnose Impact Assessment in the Southeast - 1990

by

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ABSTRACT

Two hundred and ten permanent dogwood plots have been established in dogwood anthracnose affected counties in Virginia, North Carolina, South Carolina, Georgia, Kentucky, Tennessee, and Alabama. These plots were selected as a random stratified sample on a 15-mile grid. The acreage affected in the Southeast was estimated at about 1/2 million acres in 1988, 2.2 million in 1989, and increased to 5.7 million acres in 1990. Mortality increased from 0 to 3 percent from 1988 to 1990 and the percentage of severely damaged trees increased from 4 to 11 percent.

INTRODUCTION

Dogwood anthracnose (caused by Discula sp.) was found on flowering dogwoods (Cornus florida L.) in the Northeastern United States in the late 1970's (2). All sizes and ages of dogwoods were susceptible. In 1987 the disease was found in the Cohutta Wilderness in northern Georgia. The disease causes lower limb dieback and leaf lesions on flowering dogwoods.

Because the disease was new to the Southeast, and the effects were unknown, it was decided to establish a series of permanent plots (recommended by Coleman Doggett, North Carolina Forest Service) to assess the current effects and monitor the change over time.

Since the plots occurred on all ownerships, the USDA Forest Service and the States with affected counties assisted in the establishment and monitoring of the plots. Funding was provided by the USDA Forest Service, Forest Pest Management, Washington, D.C.

METHODS

Two hundred and ten plots were established by State and Federal cooperators, depending on the ownership. The plots were installed on a 15-minute-interval latitude and longitude grid. These points were plotted using a geographic information system. They were then transferred to road maps to assist in field location. The following steps were used at the map coordinate:

1. Locate nearest road to coordinate. Plot should be located within a 1-mile radius of coordinate. If no dogwood within 1-mile radius data sheet was marked NO DOGWOOD.

2. From edge of road, determine compass heading and walk toward plot at least 2 chains (132 feet).

3. Mark plot center.

4. Locate, tag, and mark (spray paint base of tree) the 10 dogwood trees (including dead) closest to plot center regardless of size and condition. Establish plot even if less than 10 trees.

5. Make all necessary measurements and complete data sheet (Figure 1). Basal area consists of overstory trees only.

6. Collect sample of leaves or twigs from each tree suspected of having dogwood anthracnose. Mark collection bag so it can be identified by individual tree. Sample should be left dry and in a cool environment. Samples should be processed as soon as possible.

Data sheets were completed for each of the plots (fig. 1). The following Mielke-Langdon dieback classes (1) were used to rate the trees:

Dieback classes
5 = Healthy
4 = 1-25% of foliage affected
3 = 26-50% of foliage affected
2 = 51-75% of foliage affected
1 = >75% of foliage affected
0 = Dead

All of the data were entered into a computer for analysis. The percentage of plots with confirmed Discula sp. was determined for each State. The acres of dogwood for each county in each State were obtained from Forest Inventory and Analysis. These county data were used to determine the total acres in affected counties, by State. The percentage of plots affected was then multiplied by the acres to estimate the acres affected, by State.

Thirty of the 1988 plots revisited in 1989 and 1990 were used to assess the change in dieback classes using the Mielke-Langdon scale.

A GIS system was used to display the approximate location of each plot for this report.

RESULTS AND DISCUSSION

Figure 2 shows the location of the permanent dogwood anthracnose plots in the Southeast. In 1988, about 14.8 percent of the permanent plots were confirmed as positive for Discula sp. By 1989 this had increased to 27.8 percent and to 50.3 percent in 1990. Using these percentages and estimates of total dogwood, the acreage affected was estimated at 1/2 million acres for 1988, 2.2 million acres for 1989, and 5.7 million acres in 1990 (table 1).

Since each tree is classified on the Mielke-London scale, 30 plots which were infected and have been remeasured three times were compared for changes over time. Table 2 shows that mortality has increased from 0 to 3 percent and severely damaged trees (Codes 2 and 1) have increased from 4 to 11 percent. The percentage of healthy trees increased in 1990. It is felt that this increase is probably caused by a very dry growing season which reduced leaf infection.

Overall, dogwood anthracnose has made major increases in area affected and severity in the Southeast. Part of this increase is finding areas that had been infected for some time, and the other part is from new areas. The disease continues to be more severe at the higher elevations and in cool wet areas close to streams. These data are being used to construct hazard maps which are not ready for use at this time.

Table 1.--Percentage and total acres affected by dogwood anthracnose in the Southeastern United States.

State	1988 Total acres	1988 # Acres affected	1988 (%) Acre affected	1989 Total acres	1989 # Acres affected	1989 (%) Acre affected	1990 Total acres	1990 # Acres affected	1990 (%) Acre affected
GA	693,132	153,875	(22.2)	1,847,076	369,415	(20.0)	2,313,671	832,922	(36.0)
NC	1,313,906	123,507	(9.4)	1,947,729	531,730	(27.3)	2,809,184	1,519,769	(54.1)
SC	899,385	158,292	(17.6)	1,005,699	295,675	(29.4)	1,005,699	737,177	(73.3)
TN	760,277	253,172	(33.3)	2,049,881	655,962	(32.0)	2,590,118	1,313,190	(50.7)
VA	90,765	13,433	(14.8)	1,246,177	346,437	(27.8)	2,619,682	1,205,054	(46.0)
Overall	3,757,465	556,105	(14.8)	8,096,562	2,250,844	(27.8)	11,338,354	5,703,192	(50.3)

Table 2.--Percentage of dogwood trees in each of six damage classes, with changes from 1988 to 1990.

Damage class[1/]	1988	1989	1990
5	38%	8%	24%
4	51	66	48
3	7	17	14
2	3	4	7
1	1	4	4
0	0	1	3

1/ 5 = Healthy
4 = 1-25% of foliage affected
3 = 26-50% "
2 = 51-75% "
1 = >75% "
0 = Dead

Figure 1.--Data sheet used to record data at each of the 210 permanent dogwood anthracnose plots - 1990.

Dogwood Anthracnose Impact Survey
Data Sheet

Date _____ Latitude _____ Longitude _____

State _____ County _____ Surveyor _____

Aspect_____ Elevations _____ Basal area _____

Overstory type _____ Soil type _____

% slope _____ Landform (Ridge, Slope, Cove, Flatland) _____

Distance from plot center to farthest tree (ft) _____

Individual Tree Information

	1	2	3	4	5	6	7	8	9	10
Dieback Class										
DBH										
Tree Height										
Stem Infection Present?										
Sample?										

Misc. Information:

Instructions:

1. 10-tree plots on grid system.
2. Establish permanent plots - mark and number trees.
3. Record site and tree info.
4. Dieback classes: 0 = Dead, 1 = > 75% foliage affected, 2 = 51%-75%, 3 = 26-50%, 4 = 1-25%, 5 = Healthy.
5. Draw plot location and stem map on back.

Figure 2.--Approximate location of the permanent dogwood anthracnose plots in the southeastern United States - 1990.

[1]Map produced by Bob Uhler, Steve Holzman, and Charles Dull in the Regional FPM office.

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A Preliminary Hazard Rating for Dogwood Anthracnose in the Southern Appalachians

by

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INTRODUCTION

Background

In the mid-1970's, a new fungal disease was reported on dogwoods (Coruns spp.) in North America. First found near Chehalis, Washington, on Cornus nutalli, the disease was found in successive years northward into the Puget Sound region and into British Columbia. This disease caused lesions on leaves and defoliations, but usually not the death of the tree. About the same time, a new disease was found to be killing flowering dogwoods (Cornus florida) in the New York City area. This disease became known as dogwood anthracnose and was placed in the genus Discula. By the early 1980's, the disease was identified in Maryland and in 1987 in the Southern Appalachians (2). To date, it has not colonized the Atlantic Coastal Plain south of the Chesapeake Bay region, despite proximity to infected areas (1).

Issues

As more and more workers became attracted to the problem, a number of fundamental questions about dogwood anthracnose arose, such as: whether it is introduced to part or all of North America? how it is dispersed? what is the disease's potential range? what is the long-term effect? are there climatic parameters that limit fungus to identifiable geographic areas or habitats?

This project is concerned with the last question. Interagency monitoring of disease extent and severity has been tracked by Forest Pest Management in Asheville (1) for the entire upland South since 1987, and for the mid-Atlantic States since 1989. This has allowed the first gross mapping of the disease extent vs. fast distribution. Several investigators are currently examining the role of individual tree placement in shaded canopies or sunny exposures. Little, if any, previous work has been conducted at the "meso" scale--from several to tens of kilometers. This study will answer two specific, investigative questions:

1. Are there significant differences in anthracnose severity across a Southern Appalachian landscape?

2. If there are differences, can these be modeled accurately

enough to allow the classification of sites into a hazard rating system?

METHODS

Several study areas were selected in the Great Smoky Mountains National Park for intensive survey of dogwood anthracnose: Fighting Creek, west of park headquarters, Oconaluftee River above Cherokee, and a section of the Little River watershed near Chinquapin Knob. The Chinquapin Knob area was chosen for the conical knob-mountain, that has similar steepness and geology on all slope aspects. All three study sites were covered in 1989 or 1990 blooming season aerial photography by the USDA-Forest Pest Management. Aerial photos were used to ascertain general host distributions within the areas. Ground crews were then sent to rate dogwood stands continuously along transects selected to coincide with dogwoods, to bisect dogwood stands, and to extend into non-dogwood habitats.

Stands were mapped in approximately 50-meter or 100-meter cruise-widths, depending on size of survey party. Proceeding along a predetermined route, the dogwood resource, viewed as that portion of the stand within visual range, was classified into one of six categories and drawn by hand on topo sheets:

1. Few or no dogwoods
2. Little or no anthracnose apparent
3. Generally "light" infection (usually lower branches and seedlings) on up to 50 percent of trees
4. Moderate infection - more than half of trees with infection, but most not severely affected
5. Severe infection - most infected and more than half severely so, with loss of canopy and some mortality
6. Dying - half or more dying or already dead.

Currently, several vegetation-related Geographic Information System (GIS) themes are available for full-park coverage. There were tested for "best fit" with what was actually seen in the field. The GIS themes below were developed or customized by Charles Parker at the Uplands Field Research Laboratory. More details on each theme can be found in Parker, et al., 1990.

Theme	Resolution	How used
Vegetation type	$90m^2$	Comparison of 13 vegetation types made dogwood and anthracnose maps
Aspect (from Digital Elev. Model)	$90m^2$	Compared northerly (WNW to ENE aspects) to southerly aspects
Proximity to streams	Line data from USGS quads	Searched out 1, 2, and 3 pixels from stream segments of various orders

Topographic sheltering	$90m_2$	Topographic exposure checked against anthracnose and dogwood distribution
Moisture	$90m_2$	Two models with 9 and 13 classifications, based on topography, were used to compare

Various combinations of these themes were tested for "best fit" after it became obvious that single themes under or over predicted either geographic extent or severity. Since each theme may have multiple attributes (e.g., streams may be either first, second, or third order and may be searched out one, two, three, or more pixels), large matrices quickly developed. The largest matrix had 42 values to which low, moderate, and high were assigned, as general risk categories of anthracnose.

As each major theme combination was produced graphically, another transect was selected for ground truthing. Specific routes were selected to test the accuracy of the new GIS attributes used.

RESULTS

As expected, many theme attributes and some entire themes, such as the vegetation type, were found to be of little value, either singly or in combination. Also some themes encompassed disease extent well but had little sensitivity to severity of anthracnose.

The best results were obtained using the following GIS prescription:

Elevation: On northerly slopes, only elevations below 3,000 feet used due to lack of dogwood stands above that elevation. On southerly slopes, elevations below 3,500 feet were used. Dogwoods occur above that elevation, but stands are much more uncommon.

Stream proximity: Southerly slopes were considered to be at moderate risk only for the pixel through which stream flowed. Southerly slopes farther from streams were classified as of low risk. Northerly slopes were generally considered to be of moderate risk, unless within one pixel of first-order streams or two pixels of second-order streams.

Aspect: As used above.

Preliminary ground truthing indicated an accuracy of 60-70 percent for the first iteration. Autumn leaf fall prevented a more extensive assessment of accuracy. The map was run at two scales, 1:24,000 for the Fighting Creek area and at 1:117,000 for the entire park (contact author for a copy of the map).

DISCUSSION

Most dogwood anthracnose workers have recognized a difference in infection rates in different habitats when conducting field surveys (4). This study indicates that there is a significant difference across the landscape (in the

park) that may be attributable to temperature and moisture changes, which are, in turn, influenced by topography and distance from streams.

A preliminary accuracy assessment of 60-70 percent is good for geographic models. Although refinements may bring accuracy up, 100 percent is probably not achievable, since the model assumes there was a uniform distribution of fungus in both time and space, and this is extremely remote. The model's accuracy is also adversely affected by host density and weather in the months preceding the field survey. Since trees are known to be dying in the study areas, and new trees are being infected, repeatability of this project in the future may prove the ultimate test of accuracy.

In the meantime, this type of modeling may be useful in assessing which natural areas in forests and parks may be most at risk, and it should be tested and refined into localized models in other portions of the Southern Appalachians. Modeling the dogwood resources in each district of a land management agency will facilitate the prioritization of stands where in situ preservation efforts are not needed or may be a losing battle. It will also prioritize those stands for ex-situ preservation, through seed or scion collection. Since urbanized areas introduce a number of horticultural variables, it is not appropriate to use this rating system in other than natural areas at this time.

Further refinements in moisture modeling and the use of indicator species that are mappable through aerial photography, especially Rhododendron maximum or Tsuga canadensis may prove valuable in accurately assessing the dogwood anthracnose threat.

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Report# 91-1-21

EFFECTIVENESS OF CULTURAL TECHNIQUES TO CONTROL DOGWOOD ANTHRACNOSE

by

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ABSTRACT

Ornamental dogwood trees at the Bent Creek Experimental Forest in Asheville, North Carolina, were treated with different cultural techniques. All treated trees were pruned, mulched, and sprayed for dogwood borers. In addition, some trees received nitrogen, phosphorus, lime, or a balanced fertilizer, or were watered during dry periods. Check trees received none of the treatments. The trees were classified as being in full sun, in partial shade, or in full shade, and high vigor, moderate vigor, or low vigor. All trees were scored for disease symptoms on a score from 100 to 0, most severe to healthy, respectively. There was no correlation between the sun position and disease severity. All fertilizer and the water treatments were correlated with reduced disease development. Nitrogen fertilization had the lowest disease rating. It was also noted that watering in the afternoon increased disease symptoms and that cankers formed on the main stem if the epicormic shoots were not pruned.

INTRODUCTION

Dogwood anthracnose was found in the Northeastern United States in the late 1970's. The Northeast recommended a number of cultural control techniques for dogwood anthracnose. Since the South has a longer growing season and a variety of environmental conditions, Region 8, Forest Pest Management, began a pilot test in 1989 to evaluate these control recommendations under southern conditions.

At the Bent Creek Experimental Forest, Asheville, North Carolina, a number of ornamental dogwoods became infected in 1989. The dogwoods were treated as recommended by the North, except no fungicides were applied. There were no

prolonged dry periods in 1989, so watering was not needed. There were five trees used as check trees that received no treatment.

Overall, the treated trees appeared to be more healthy and the treatments did not stimulate or reduce dogwood anthracnose symptoms.

In 1990, the evaluation was continued and expanded to evaluate the effects of watering during dry periods or fertilization with high rates of nitrogen, phosphorus, lime, or a balanced fertilizer.

METHODS

All treated trees were pruned, mulched, and treated with Dursban for dogwood borer control. Five trees were left untreated as checks. The following treatments were applied in the spring of 1990:

1) Watering during prolonged dry periods, plus 10-20-10 fertilizer (rate:1.5#/diam. in.)
2) Fertilizing with a high nitrogen (16-0-0) fertilizer (rate:3#/diam. in.)
3) Fertilizing with a high phosphorus (0-46-0) fertilizer (rate:5#/diam. in.)
4) Fertilizing with lime only (rate:200#/1,000 ft^2)
5) Fertilizing with recommended fertilizer after soil analysis (10-20-10) (rate:1.5#/diam. in.)

Each treatment was replicated twice with three to six trees per replication. A buffer zone was left around each treatment to prevent different treatments from affecting each other. The fertilizer and lime were applied by broadcasting the material between the trunk and drip line. A soil analysis was made of each replication area before and at the end of the growing season.

The trees were rated for dogwood anthracnose in September, by finding the least affected and the most affected trees, which received scores of 0 and 100 percent, respectively. All other trees were estimated as to where they fit on the scale from 0 to 100 percent. The trees were also rated for the amount of sunlight exposure (full sun, partial shade, and full shade) and vigor (high vigor, moderate vigor, and low vigor).

RESULTS AND DISCUSSION

There was no significant difference in the symptoms on the trees in the different sun positions. There was a significant difference in symptoms on trees in different vigor classifications (fig. 1). Trees in full shade achieved only a moderate or low vigor rating. The average score on the basis of 0-100 percent was 27 for low vigor trees, 17 for medium vigor, and 8 for high vigor.

When the trees are grouped by vigor classes, the analysis of covariance showed that all treatments had less disease symptoms when compared with the checks. Nitrogen was the only treatment that had significantly less symptoms when compared with other treatments. These data show that all treatments seemed to reduce disease severity (table 1).

It was also noted that afternoon watering increased the disease and that if cankers formed on the main stem epicormic shoots were not removed.

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Figure 1.--The average score for trees affected by dogwood anthracnose on basis of 0-100 percent for tree vigor, with the most severely tree rated as 100 and the healthiest as 0.

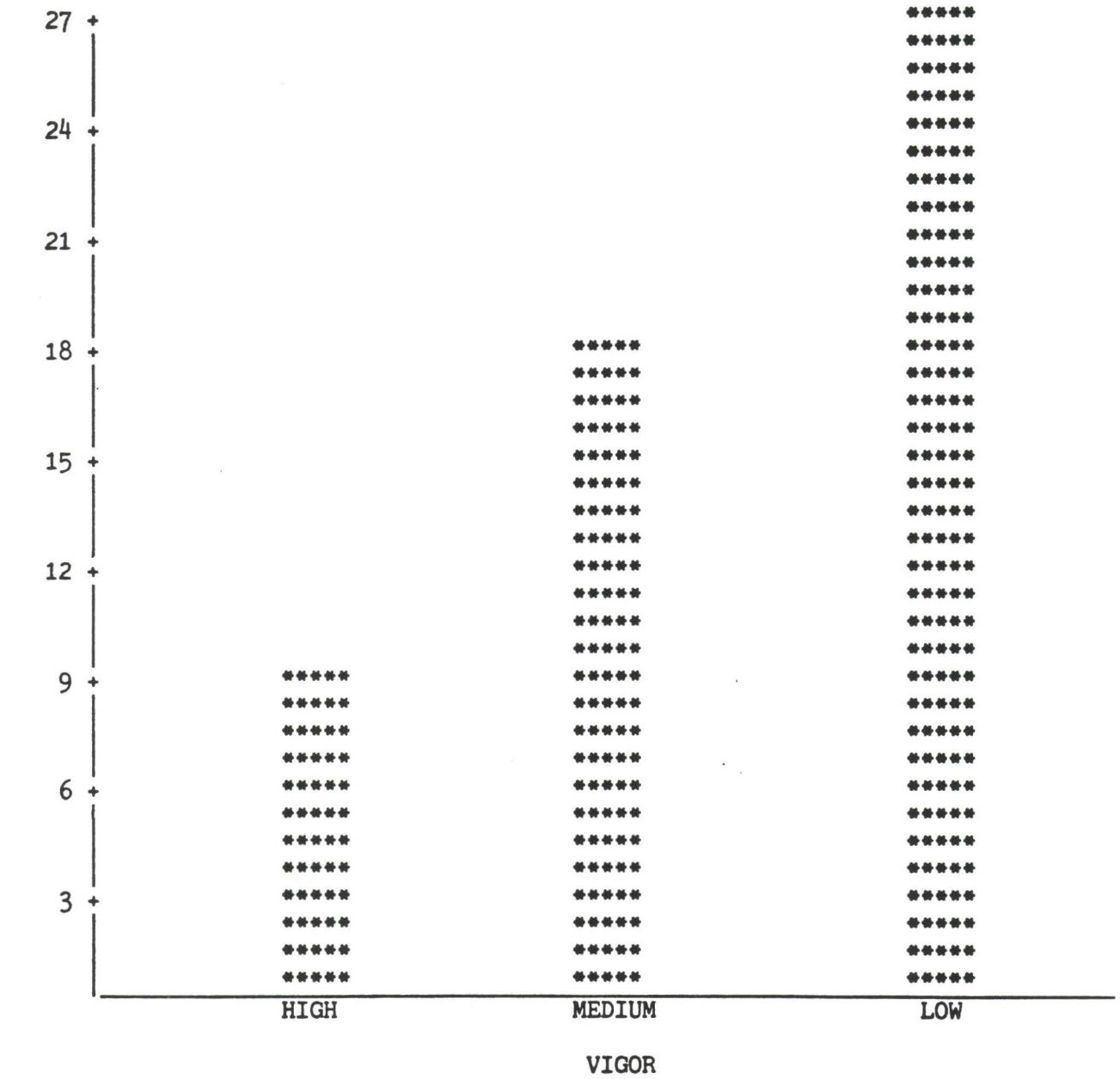

Table 1.--Severity of dogwood anthracnose on trees treated with different cultural or fertilizer treatments. The Duncan's multiple range test was run taking the affects of vigor into consideration.

Duncan	Grouping	Mean	Treat
	A	34.94	Check
B	A	27.57	Balanced
B	A	19.78	Water
B	A	14.94	Phosphorus
B	A	12.40	Lime
B		10.08	Nitrogen

Residual Effects of Control Strategies Applied in the Previous Year

by

Mark T. Windham, Alan S. Windham, and Keith R. Langdon

The use of fungicide treatments and pruning were evaluated in 1989 for disease control (1). In the 1989 experiments, pruning was ineffective in reducing dogwood anthracnose disease severity, whereas fungicide treatments were very effective. The objectives of this study were (1) to determine if symptom severity continued to be reduced in the next growing season and (2) to determine if beneficial effects of pruning had appeared the following year.

METHODS

In 1989, four dogwoods in the Great Smoky Mountains National Park (GSMNP) trees were sprayed three times (approximately 15 days apart) with either Benlate, Daconil 2787, Fore, or Zyban (1). Another six trees served as controls. Trees had been evaluated for symptom severity using the Mielke-Langdon scale (2). These trees were evaluated for dogwood anthracnose symptom severity on August 11, 1990, using the same scale.

In 1989, 23 pairs of dogwood trees had been selected in GSMNP because they were similar in d.b.h. and symptom severity and were spaced < 8m apart. One member of each pair had been pruned monthly to remove diseased tissue. In 1990, trees of each pair were evaluated using the Mielke-Langdon scale.

Data from the fungicide trail were analyzed using the ANOVA procedure of SAS and Duncan's new multiple range test. Data from the pruning experiment was evaluated using a paried T-test.

RESULTS AND DISCUSSION

Trees sprayed in 1989 with fungicides had significantly lower symptom severity scores in 1990 than did control-trees (1). Two control trees had died. Fungicide treatments from the previous year may have resulted in less initial inoculum of Discula within the tree canopies in 1990.

No significant differences were observed in symptom severity ratings in the pruning experiment. Mielke-Langdon scores averaged 3.8 for the pruning treatment and 3.9 for the controls.

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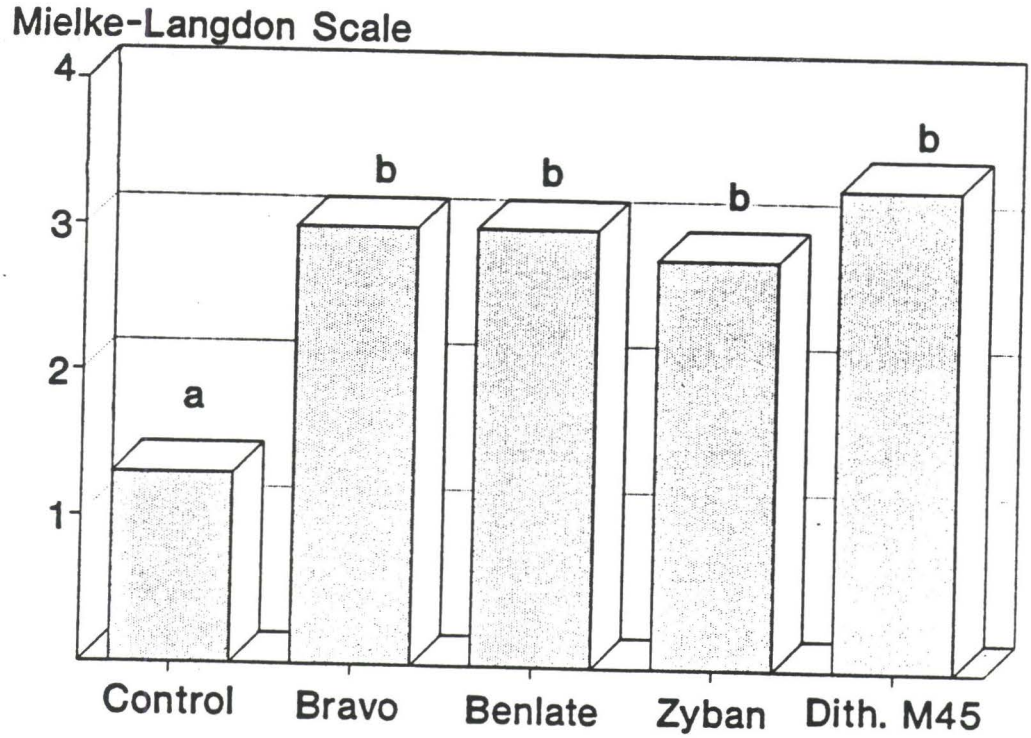
Figure 1.--Effects of fungicide sprays applied in 1989 on symptom severity in 1990.



Use of Fungicidal Sprays and Pruning to Control Dogwood Anthracnose in a Nursery Field

by

Mark T. Windham and Alan Windham

Dogwood anthracnose was detected in a commercial nursery in 1990. The nursery field consisted of 22 rows and each row was 285 m long. Disease incidence in the field was nearly 100 percent, but a gradient in disease severity ranging from severe to mild symptoms was observed. Initially, most lesions were located in the lower canopy of most trees. The field was obtained from the nurseryman for use in fungicide control trial.

Ten fungicide treatments, including an untreated control, were evaluated using a randomized complete block design with six replications. Each replication consisted of a 1 row plot (6 m long). Fungicides were used at label rates. In addition, pruning out disease tissue was also evaluated with and without fungicide treatments as a control strategy. In treatments involving pruning, trees were examined for diseased tissue and symptomatic tissue was removed. Pruning was conducted only once. Disease severity was rated using the Mielke-Langdon Scale (1) and a canopy scale (table 1).

Continued disease development was hampered by unusually dry and hot weather during June, July, and August. Differences between treatments were not detected using the Mielke-Langdon scale, but were apparent using the canopy scale method (table 2). All fungicide treatments were effective in reducing the level of disease in the canopy when compared with the controls. Pruning was effective in reducing the amount of disease in the canopy when compared with the control. However, pruning + fungicide was no more effective in disease control then fungicide treatments alone.

Literature Cited

1. Mielke, M. and Langdon, K. 1986. Dogwood anthracnose fungus threatens Catoctin Mt. Park. Park Sci. Winter: 6-8.

Table 1.--Canopy scale values.

Score	Portion of canopy (from the base of tree) with disease
0	Canopy is healthy
1	1 - 20%
2	20 - 40%
3	40 - 60%
4	60 - 80%
5	80 - 100%

Table 2.--The effectiveness of 10 fungicidal treatments used with and without pruning for control of dogwood anthracnose.

Fungicide treatment	Pruned Yes	Pruned No	Mielke-Langdon scale	Canopy scale
ASC 66791		No	3.4 a	1.6 ab
		Yes	4.0 a	1.2 a
Banner 1.1 E		No	4.0 a	1.6 ab
		Yes	4.4 a	1.2 a
Benlate 50 DF		No	4.2 a	1.0 a
		Yes	4.4 a	1.0 a
Bravo 720		No	3.8 a	1.4 a
		Yes	3.8 a	1.4 a
Control		No	3.4 a	3.8 d
		Yes	3.8 a	2.6 c
Dithane DF		No	4.0 a	1.4 a
		Yes	4.0 a	1.2 a
Hydroclear's Ionic solution		No	4.0 a	1.8 ab
		Yes	3.8 a	2.2 bc
Lynx 2 F		No	4.0 a	1.0 a
		Yes	4.0 a	1.2 a
Systhane 2 EC		No	3.4 a	1.8 ab
		Yes	4.0 a	1.6 ab
SAN 619		No	3.8 a	1.8 ab
		Yes	4.0 a	1.6 ab

Numbers in each column followed by a letter do not differ according to Duncan's multiple range test (P = 0.05).

Dogwood Anthracnose Studies

by

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University of Georgia

SUMMARY

Of the registered materials, Benlate and Daconil gave the best control of dogwood anthracnose leaf symptoms. While Benlate was statically better, both materials gave adequate control. Lynx, not registered for use on dogwood, was as effective as a foliar spray as Benlate. Due to the potential resistance problem with Benlate, it is suggested that the materials be mixed or alternated in a common spray schedule. Trunk injections with Aliette, Lynx, Arbotect, and Plant Vax were relatively ineffective in reducing foliar symptoms regardless of time or number of injections.

Evaluation of the effects of foliar sprays and trunk injections on the control of dogwood anthracnose

Studies were established during 1990 at Duke's Creek in the Georgia mountains. Foliar spray, trunk injection, and soil drench tests were established. Foliar sprays were applied to both leaf surfaces to runoff on a 2-or 3-week schedule beginning March 19 and ending June 27. The following fungicides were tested (formulation concentration/3.8 l water): Benlate 50DF-4.7 mL, Daconil 54%-5.7 g (2-week interval), 11.3 g (3-week interval), ASC66971-9.1 g, and Lynx-3 mL. The soil drench was applied on March 19 using 1 and 2 mL of Lynx per cm of trunk diameter in 3.8 L of water to the drip line area. Trunk injections were made on September 29, 1989; May 1, 1990; June 27, 1990; and September 24, 1990. The injection sites were placed 12 cm apart around the trunk near the root flare. Arbotect, Lynx, Plant Vax, and a combination of Arbotect and Plant Vax were injected fall and spring. Aliette was injected fall, summer, and spring. Disease assessments were made on a percentage of leaf area showing necrosis on a scale of: 0 = no symptoms, 1 = trace to 5 percent, 2 = 6-25 percent, 3 = 26-50 percent, 4 = 51-75 percent, 5 = 76-100 percent, 6 = leaf abscised. Twenty-five leaf pairs in the lower crown of each tree were related on May 29, June 19, and July 20. In the trunk injection test, it was necessary to prune limbs from the lower crown for rating due to size of the trees. Each treatment was replicated four times. Data were analyzed using ANOVA and means separated using Duncan's multiple range test.

Disease incidence and intensity were severe until July 1, when it became dry. The results of the spray test are presented in table 1. In general, Benlate and Lynx gave the best control. On the final data, ASC66971 suppressed leaf symptoms almost as well. While Daconil was the least effective on the 2-week schedule, it was effective enough to give good control.

Although Benlate had a statistical advantage in control, it has the disadvantage of giving rise to resistant stains of fungi when used alone. Control can probably be best realized using a mixture of Benlate and Daconil, or alternating the use of the two materials.

None of the injected materials at Duke's Creek gave adequate control of dogwood anthracnose, whereas at the Georgia Mountain Experiment Station no symptoms were evident due to inadequate rainfall and warm temperatures. While it appeared that the spring injection of Lynx controlled the disease, it should be noted that the fall/spring treatment which was made at the same time in the spring was ineffective. Thus, trunk injection with these compounds appears to be erratic at best.

Effect of soil fertilization on dogwood anthracnose

A field study was started to supplement the pot study on fertilization effects reported in 1989. Five tree plots were established at the Georgia Mountain Experiment Station in Blairsville. Fertilization treatments involving NH_4NO_3, $CaHPO_4$, and $Ca(OH)_2$ were applied on April 13. Treatment levels were either high or medium for each nutrient according to the UGA Soil and Plant Testing Laboratory standards for dogwoods. All possible combinations were tested, giving nine treatments. The test was replicated four times. Overhead irrigation was installed to maintain moisture for growth and for inoculations. Two inoculations were made on August 22 and September 17. Due to relatively warm temperatures, symptom development was insufficient to evaluate the test. The test will be inoculated in the spring of 1991, and results will be included in the 1991 report.

Table 1.--Dogwood anthracnose fungicide spray test - 1990

Treatment	rate (per gallon)	5-29-90	6-19-90	7-20-90
			Every 2 weeks	
Benlate	4.7 mL	0.07500 E	0.07000 E	0.05000 D
Daconil	5.7 g	0.21667 D	0.17262 D	0.36628 B
Daconil	11.3 g	1.36000 A	1.27000 A	1.22000 A
ASC66971	9.1 g	0.34000 C	0.29500 C	0.19500 C
Lynx	3 mL	0.02500 E	0.10500 DE	0.08500 D
Control		0.57000 B	0.51500 B	0.22500 C

Table 2.--Dogwood anthracnose soil drench test

Treatment rate		5-29-90	6-19-90	7-20-90
Lynx	2mL/cm stem	1.64500 A	1.66500 A	1.60900 A
Lynx	1mL/cm stem	1.68000 A	1.60000 A	1.45000 B
Control		0.57000 B	0.51500 B	0.22500 C

Table 3.--Dogwood anthracnose fall trunk injection test

Treatment	5-29-90	6-19-90	7-20-90
Arbotect	1.56500 A	2.22500 A	1.77000 B
HWG 1608 (Lynx)	1.32500 B	1.89500 B	1.71500 B
Plant Vax	1.56000 A	1.66500 B	1.86000 B
Combo Plant Vax & Arbotect	1.32500 B	2.30000 A	2.24000 A
Control	1.45500 AB	1.62000 B	1.56000 B

Table 4.--Dogwood anthracnose fall/spring trunk injection test

Treatment	5-29-90	6-19-90	7-20-90
Arbotect	1.20000 C	1.48670 D	1.56670 C
HWG 1608 (Lynx)	1.75000 B	2.98500 A	2.57000 A
Plant Vax	1.55000 B	1.76500 BC	1.57500 C
Combo Plant Vax & Arbotect	2.00000 A	1.97500 B	2.22000 B
Control	1.60500 B	1.58000 CD	1.62000 C

Table 5.--Dogwood anthracnose spring trunk injection test

Treatment	5-29-90	6-19-90	7-20-90
Arbotect	1.20000 C	1.73000 A	1.38500 BC
HWG 1608 (Lynx)	0.61000 C	1.00500 C	1.16000 C
Plant Vax	1.03000 A	1.42000 B	1.64000 B
Combo Plant Vax & Arbotect	1.17500 A	1.65500 AB	1.35000 BC
Control	0.82500 B	1.58500 AB	2.48500 A

Table 6.--Dogwood anthrancose spring spring/summer fall trunk injection

Treatment	5-29-90	6-19-90	7-20-90
Aliette	1.36000 A	1.75500 A	1.33500 B
Aliette	1.29000 A	1.00000 B	0.77500 C
Aliette	1.01000 B	1.13500 B	1.38000 B
Control	0.82500 B	1.58500 AB	2.48500 A

Chemical and Cultural Control of Dogwood Anthracnose At Lookout Mountain National Park

by

Mark T. Windham, Alan S. Windham, and Keith R. Langdon

Dogwood anthracnose epidemics had been severe on Lookout Mountain in 1989 (2) in both urban and forest areas. Pilot tests including both chemcial and cultural control methods were utilized in 1990 to determine if anthracnose symptom severity could be reduced. The objectives of this study were: to determine the effects of amount of sunlight or shade on symptom development, (2) to determine if mulching and irrigation would reduce symptom severity, and (3) to evaluate the effectiveness of fungicides applied as drenches, injections, and foliar sprays.

Methods

Sun vs. shade. Twenty-nine plots in urban areas of Lookout Mountain and Signal Mountain were established in 1990. Each plot consisted of 10 trees that were at least 1 m tall. The type of sunlight that each tree was subjected to was determined using the scale listed in table 1. Landscapes were also classified as very open (few shrubs, no trees other than dogwoods), open (few trees other than dogwoods), woody (most dogwoods under canopies of other trees, and very woody (dogwoods under dense tree canopies and many shrubs and bushes). The Mielke-Langdon (ML) (1) scale was used to evaluate symptom severity.

Irrigation and mulching. Twenty trees at "The Commons," a Lookout Mountain city park, were used in a study to evaluate the effects of irrigation and mulch on anthracnose disease incidence. Ten trees were mulched with hardwood bark mulch and irrigated daily with pop up nozzles that directed water at the base of the trees. The other 10 served as controls. Symptom severity was rated using the ML scale.

Injectors. Twenty-four trees, average d.b.h. = 9.7 cm, were used in a trial evaluating Mauget injectors. Trees were injected at recommended rates with Mauget injectable fertilizer, Fungisol, Fungisol + fertilizer, Fungisol PV, or Fungisol PV + fertilizer. Each treatment was replicated four times and four times served as controls. Trees were rated for symptom severity before the study began using the ML scale and again on August and October.

Fungicide sprays and drenches. Another fungicide trail was conducted on potted dogwood trees that were set underneath the canopies of diseased dogwoods. Banner and Lynx were used in two treatments each as a root drench and a foliar spray. The fungicides Bravo 720, Dithane DF, Zyban, and Benlate were applied as foliar sprays. Ionic solutions (made by Hydroclear Inc.) were applied as foliar sprays and also evaluated. Trees were sprayed throughout the summer on a 2-week spray schedule. Each treatment was replicated eight times served as controls.

Results and Discussion

Sun vs. shade. Disease severity was not significantly correlated with the amount of sunlight or shade that trees experienced during the day. These data disagree with observations made in 1989 and this disagreement may have been due to unfavorable environmental conditions (hot and dry) for disease development that experienced throughout the summer. No differences in symptom severity were noted in open vs. woody environments.

Irrigation and mulching. No significant differences in symptom severity were observed between trees irrigated and mulched and trees that served as controls. Although symptoms were moderately severe in late spring, symptoms did not continue to progress in any treatment as the summer progressed.

Injectors and fungicide sprays and drenches. Foliar anthracnose symptoms were very severe at the beginning of the study (table 2). As the season progressed, few additional lesions developed on new foliage and symptom severity ratings decreased. No signficant differences were noted between treatments in either study (tables 3 and 4).

Literature Cited

1. Mielke, M. and Langdon, K. 1986. Dogwood anthracnose fungus threatens Catoctiin Mt. Park. Park Sci. Winter:6-8.

2. Windham, M. 1989. Epidemiology of dogwood anthracnose in Cherokee National Forest of Southeastern Tennessee. Phytopathology (ABSTRACT). 79:1149.

Table 1.--Rating scale for type of light dogwoods experienced in urban settings.

Type of sunlight	Score
Direct sun	6
Mostly sun	5
Partial sun	4
Direct shade	3
Mostly shade	2
Total shade	1

Table 2.--Symptom severity data with and without Mauget fungicide and fertilizer treatments.

Treatment	Initial rating	Symptom severity rating	
		August 1	September 10
Control	1.8	2.3	2.9
Control + fertilizer	1.8	2.4	2.7
Fungisol	1.3	2.2	3.1
Fungisol + fertilizer	2.1	2.5	2.9
Fungisol PV	1.3	2.4	3.0
Fungisol PV + fertilizer	1.5	2.6	3.1

Table 3.--Data for fungicide treatments on potted dogwoods.

Fungicide treatment	Symptom severity rating		
	August 1	August 15	September 12
Banner - Drench	5.0	4.2	3.8
Banner - Spray	5.0	4.5	4.4
Lynx - Drench	5.0	4.3	4.0
Lynx - Spray	5.0	4.8	4.8
Bravo 720	5.0	4.3	4.0
Dithane-M45	5.0	4.2	4.3
Zyban	5.0	4.4	4.5
Control	4.8	3.9	3.8
Ionic solutions - Cu	5.0	3.9	4.1
- Cu + I	5.0	4.2	4.0
- Ag	4.9	3.8	3.9
- Ag + I	5.0	4.5	4.2

Report #91-1-19

A Pilot Test of the Fungicide Lynx Used as a Soil Drench to Control Dogwood Anthracnose

by

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Plant Pathologist

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ABSTRACT

Flowering dogwood (Cornus florida L.) that were severely affected by dogwood anthracnose (caused by Discula sp.) on the Bent Creek Experimental Forest were used to pilot test the fungicide Lynx as a soil drench for the control of dogwood anthracnose. The trees were treated by pouring a dilute mixture of the chemical in holes that had been bored in the soil around the drip line. There were no differences in the severity of the disease from May 1990 to September 1990 in the treated trees. There were also no differences in the severity of the disease in the control trees. Lynx applied as a soil drench did not reduce dogwood anthracnose symptoms in this pilot test.

INTRODUCTION

Dogwood anthracnose (caused by Discula sp.) was found on flowering dogwoods (Cornus florida L.) in the Northeastern United States in the late 1970's (3). All sizes and ages of dogwoods were susceptible. In 1987 the disease was found in the Cohutta Wilderness in northern Georgia and now has been found in 117 counties in 7 Southeastern States (1). It is primarily found in the mountains and foothills.

Lynx has been successfully used as a spray to control dogwood anthracnose. This pilot test was done to see if Lynx would control dogwood anthracnose on flowering dogwood when used as a soil drench.

METHODS

A location in the forest, where flowering dogwoods (Cornus florida L.) were known to be severely infected with dogwood anthracnose (caused by Discula sp.) on the Bent Creek Experimental Forest, was chosen as the site for a soil drench pilot test using the fungicide Lynx. There were 5 blocks of 10 trees each. Each block had six treated trees and four control trees.

Ten holes one and 1 1/2 inch diameter and 3 inches deep were drilled in the soil around the drip line of each tree. Lynx was applied at 8 grams of active ingredients per centimeter of tree diameter. The calculated amount of fungicide was diluted in 1/2 gallon of water for each treated tree.

Equal volumes of the dilution were poured into each hole around the treated trees. One-half gallon of water was poured equally into the holes around the control trees.

The pilot test was installed in mid-April at the time of dogwood flowering. Evaluations (using the Mielke-Langdon damage classes) (2) were recorded once a month beginning in June and ending in September.

RESULTS AND DISCUSSION

We wanted high disease pressure on the fungicide, so the area chosen was severely infected with dogwood anthracnose. There were 30 treated and 20 control trees in the evaluation. Those trees treated with the fungicide Lynx as a soil drench showed no evidence of reduced disease symptoms (table 1). The difference in disease severity between June and September was 0.36 for the treated trees and 0.10 for the control trees (table 1).

Table 1.--Average severity of dogwood anthracnose infection on the Lynx plots using the Mielke-Langdon damage classes.[1/]

Plot number	June reading		September reading	
	Treated trees	Control trees	Treated trees	Control trees
1	1.80	1.50	2.33	1.75
2	2.83	2.25	3.17	2.75
3	1.67	2.25	2.33	2.25
4	1.50	2.25	1.83	1.75
5	2.50	2.00	2.50	1.75
Average	2.07	2.05	2.43	2.05

[1/] 5 - Healthy
4 - 1-25% of foliage affected
3 - 26-50% of foliage affected
2 - 51-75% of foliage affected
1 - > -75% of foliage affected
0 - Dead

LITERATURE CITED

1. Anderson, R.L., J.L. Knighten, and S.E. Dowsett. 1990. Dogwood Anthracnose: A Southeastern United States Regional Perspective. In Proceeding of 23rd Annual Tennessee Nursery Short Course, February 14-16, 1990, Nashville, TN, p. 242-253.

2. Mielke, M. and K. Langdon. 1984. Dogwood Anthracnose Fungus Threatens Catoctin Mountain Park. Park Science, Winter 1986. USDI National Park Service.

3. Daughtrey, M.L., C.R. Hibben, and G.W. Hudler. 1988. Cause and Control of Dogwood Anthracnose in Northeastern United States. Journal of Arboriculture 14(2):55.

ACKNOWLEDGMENT

Thanks to Mobay Corporation for supplying the fungicide used in this pilot test.

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Report #91-1-18

A Pilot Test of the Fungicide Banner Used as a Soil Drench to Control Dogwood Anthracnose

by

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Cathy Henson
Biological Laboratory Technician

ABSTRACT

Flowering dogwoods (Cornus florida L.) that are severely affected by dogwood anthracnose (caused by Discula sp.) on the Bent Creek Experimental Forest were used to pilot test the fungicide Banner as a soil drench for the control of dogwood anthracnose. The trees were treated by pouring a dilute mixture of the chemical in holes that had been bored in the soil around the drip line. There were no differences in the severity of the disease from May 1990 to September 1990 in the treated trees. There were also no differences in the severity of the disease in the control trees. Banner applied as a soil drench did not reduce dogwood anthracnose symptoms in this pilot test.

INTRODUCTION

Dogwood anthracnose (caused by Discula sp.) was found on flowering dogwoods (Cornus florida L.) in the Northeastern United States in the late 1970's (3). All sizes and ages of dogwoods were susceptible. In 1987 the disease was found in the Cohutta Wilderness in northern Georgia and now has been found in 117 counties in 7 Southeastern States (1). It is primarily found in the mountains and foothills.

Banner has been successfully used as a soil drench in the control of anthracnose on pecan Carya illinoensis (Wangenh.) K. Koch. The pilot test was done to see if Banner would control dogwood anthracnose on the flowering dogwood.

METHODS

A location in the forest, where flowering dogwoods (Cornus florida L.) were known to be severely infected with dogwood anthracnose (caused by Discula sp.) on the Bent Creek Experimental Forest, was chosen as the site for a soil drench pilot test using the fungicide Banner. There were 5 blocks of 10 trees each. Each block had six treated trees and four control trees.

Ten holes 1 1/2 inch diameter and 3 inches deep were drilled in the soil around the drip line of each tree. Banner was applied at 15 grams of active ingredients per tree. The calculated amount of fungicide was diluted in 1/2 gallon of water for each treated tree.

Equal volumes of the dilution were poured into each hole around the treated trees. One-half gallon of water was poured equally into the holes around the control trees.

The pilot test was installed in mid-April at the time of dogwood flowering. Evaluations (using the Mielke-Langdon damage classes) (2) were recorded once a month beginning in June and ending in September.

RESULTS AND DISCUSSION

We wanted high disease pressure on the fungicide, so the area chosen was severely infected with dogwood anthracnose. There were 30 treated and 20 control trees in the evaluation. Those trees treated with the fungicide Banner as a soil drench showed no evidence of reduced disease symptoms (table 1). The difference in disease severity between June and September was 0.07 for the treated trees and 0.10 for the control trees (table 1).

Table 1.--Average severity of dogwood anthracnose infection on the Banner plots using the Mielke-Langdon damage classes.[1/]

Plot number	June reading		September reading	
	Treated trees	Control trees	Treated trees	Control trees
1	3.00	2.75	3.00	3.00
2	2.67	2.75	2.67	3.00
3	3.00	3.25	3.17	3.00
4	3.00	3.25	3.00	2.75
5	2.83	3.50	3.00	3.25
Average	2.90	3.10	2.97	3.00

[1/] 5 - Healthy
4 - 1-25% of foliage affected
3 - 26-50% of foliage affected
2 - 51-75% of foliage affected
1 - > -75% of foliage affected
0 - Dead

LITERATURE CITED

1. Anderson, R.L., J.L. Knighten, and S.E. Dowsett. 1990. Dogwood Anthracnose: A Southeastern United States Regional Perspective. In Proceeding of 23rd Annual Tennessee Nursery Short Course, February 14-16, 1990, Nashville, TN, p. 242-253.

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3. Daughtrey, M.L., C.R. Hibben, and G.W. Hudler. 1988. Cause and Control of Dogwood Anthracnose in Northeastern United States. Journal of Arboriculture 14(2):55.

ACKNOWLEDGMENT

Thanks to CIBA-GEIGY Corporation for supplying the fungicide used in this pilot test.

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Report #91-1-03

EVALUATION OF A GROWTH RETARDANT FOR EPICORMIC SHOOT CONTROL ON FLOWERING DOGWOODS

by

Robert L. Anderson
Ken Knox
John Knighten

ABSTRACT

Maintain A tree sprout growth retardant was used to reduce epicormic shoots on dogwood. The treatment caused stem and branch deformity in smaller trees and is not recommended for operational use.

INTRODUCTION

Dogwoods have a tendency to produce epicormic shoots on the main stem of the tree. These are more common on trees under stress. It has been noted that dogwood anthracnose causes an increase in the number of these shoots. The tender young shoots are highly susceptible to Discula sp., which causes dogwood anthracnose. The fungus can quickly move down these shoots and cause main stem cankers. One of the control recommendations is to prune these shoots off the tree to keep the cankers from developing. This appears to work well but multiple shoots can develop after pruning. Maintain A is a chemical shown to reduce epicormic shoots in other species of trees. This product was tested on trees infected by Discula sp.

METHODS

Twenty Discula sp. infected dogwoods with epicormic shoots that ranged in size from 5 inches to 1 inch were selected for treatment. The shoots were pruned off flush with the stem and Maintain A, which contains Chlorofluernol was sprayed on the pruned area in accordance with the label. The trees were treated in May and readings were made in September 1990.

RESULTS AND DISCUSSION

On trees larger than 2 inches in diameter, the number of new sprouts was almost eliminated and we did not see an adverse effect to the tree. The number of sprouts on trees smaller than 2 inches was reduced, but the chemical was translocated and caused leaf and stem deformity. Also, small branches on large trees were sprayed and resulted in the same problem. Because of this adverse effect, we do not recommend the use of this product to control epicormic sprouts on dogwoods.

EPICORMIC SHOOT DIEBACK OF FLOWERING DOGWOOD CAUSED BY *DISCULA* SP. DURING DORMANCY

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ABSTRACT

Increased dieback of epicormic shoots was observed on flowering dogwood (*Cornus florida*) after the tree had gone dormant in 1987 and 1988. Further verification of this observation was made during the dormant season (October to May) in 1989. During the evaluation, 66 percent of the shoots had varying amounts of dieback, 17 percent died back to the main stem while 17 percent remained unchanged. The evaluation showed that the increase in dieback occurred after an extremely cold period. The progression of dieback was limited by shoot internodes.

Correlation Between Simulated Acid Rain and Dogwood Anthracnose in the Greenhouse

by

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Bare-root, 1-year-old Cornus florida seedlings were planted in 1 liter pots in a mixture of 5 parts peat moss, 4 parts perlite, and 3 parts pasturized top soil. When leaves had emerged under controlled greenhouse conditions, the seedlings were exposed to one of four simulated acid rains of 2.5, 3.5, 4.5, and 5.5 at the Center for Forest Environmental Studies. After 10 exposures the seedlings were sealed in plastic bags and transported to the Resistance Screening Center where they were inoculated with Discula sp., the dogwood anthracnose fungus. After 21 days the seedlings were read by assessing the percentage of leaves infected and the severity of the affected leaves. The study was done in 1989 and repeated in 1990. The results for 1989 and 1990 showed that severity of Discula sp. caused symptoms increased as the simulated acid rain pH decreased from 5.5 to 2.5 (See following chart).

Percent of leaves affected

Rain pH	1990	1989
2.5	32 a	54 a
3.5	21 a b	23 b
4.5	17 b c	26 b
5.5	9 c	.4 c

Severity of injury

Rain pH	1990	1989
2.5	71 a	78 a
3.5	59 a b	49 b
4.5	46 b	42 b
5.5	26 c	1 c

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